



Operation and Maintenance

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Design

Commissioning

Operation and Maintenance

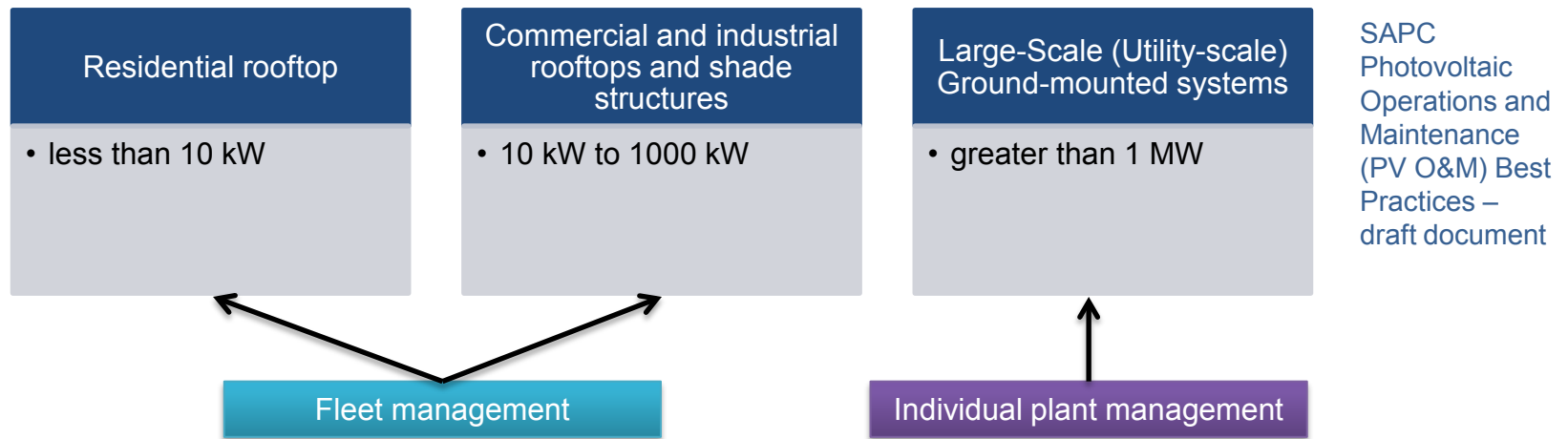


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Categories of Photovoltaic Power Plants – based on size



A standard which encompasses all categories and delineates between them is possible, but will be challenging.



From ASTM WK43549 - Installation, Commissioning, Operation and Maintenance Process (ICOMP) of Photovoltaic Arrays

Operation & Maintenance –

procedures to assure functionality of system components and connections for reliability, safety and fire prevention; monitoring of performance indicators, measures to track and maximize anticipated performance, diagnostic measures, troubleshooting, and documentation.



Image from TUV

Critical Aspects of PV System Life

- System up-time (availability)
- System capacity and energy yield
- Safety-related issues



Technical details for IECRE PV systems certification



From ASTM WK43549 - Installation, Commissioning, Operation and Maintenance Process (ICOMP) of Photovoltaic Arrays

Operation and Maintenance – a PV power plant should have an O&M plan which includes the following considerations:

- Periodic validation of system performance (power output), based on performance modeling developed in the design process and initial results during commissioning
- Service records and reporting of operational issues
- As-built drawings that are readable and accurate
- Site maintenance and safety plan
- Documented process for performance monitoring
- Documented and detailed process for periodic verification of safety and performance
- Mandatory annual preventive maintenance (PM) plan and warranty documentation
- Cleaning plan and vegetation control plan
- Documentation of warranty, service level agreement and claims process
- Agreed expectations for response time to operational problems
- Provisions for “invasive” testing if necessary for troubleshooting of operational problems
- Process for root cause analysis, emphasizing transparency and preventive action

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Commissioning

Operation and Maintenance



Technical details for IECRE PV systems certification



From IEC working draft, Maintenance of PV Systems – IEC number not yet established

Operations

- Forecasting
- Grid-driven curtailment
- Voltage regulation
- Other activities of operation not relating to maintenance

Maintenance

- Preventative and performance related maintenance procedure
- Corrective maintenance
- Troubleshooting
- Record-keeping

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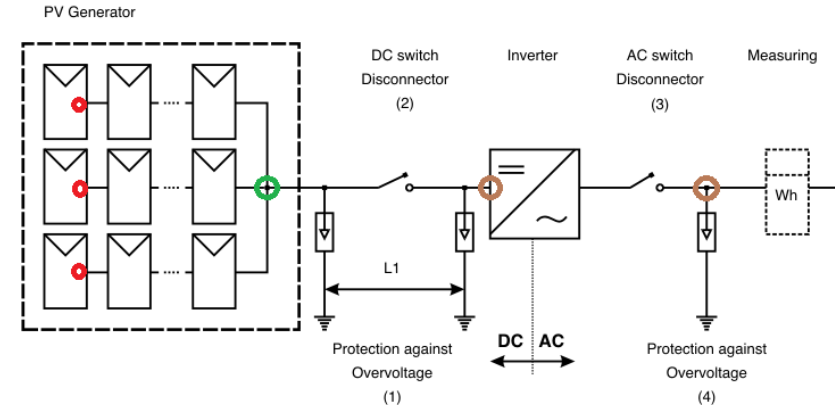
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Evaluating the Supervisory Control and Data Acquisition system and provider (SCADA)

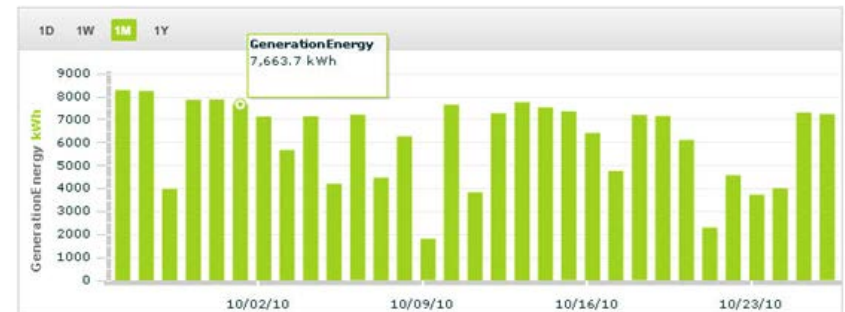
Quality system – attributes of ISO 9001

Records – Alarms, downtimes, low performance, safety issues, system availability

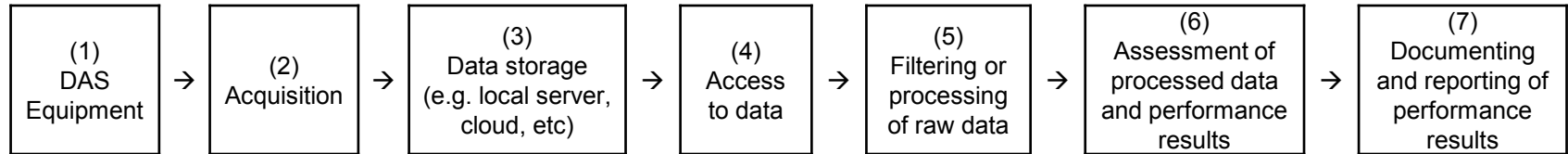
IEC 61724 –
Photovoltaic system performance monitoring -
Guidelines for measurement, data exchange and
analysis



Production Chart



Evaluating the Supervisory Control and Data Acquisition system and provider (SCADA)



The following is a very general quality audit criteria that can be considered for the SCADA system:

(1) – calibration/traceability and accuracy of the sensors

(4) – Compatibility of data transfer; use of applicable standards (e.g. Sunspec) compliance; standard operation procedures; redundancy; security of customer data

(5) – Software stability; use of internal standards; operating procedures, security; qualification of personnel; stages of documentation; review process

(6) – Software or assessment criteria by expert; qualifications; process, procedures, and documents; security

(7) – Reporting of data

* Methods of (2) and (3) may be proprietary and as such might only be confirmed but not considered for evaluation.

Maintenance



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From IEC working draft, Maintenance of PV Systems – IEC number not yet established

Table 1 – Recommended maintenance intervals by system classification

* These intervals are a special case required for functionally earthed systems without sensitive earth-fault protection.

Class	A	B	C
Diligence level	High	Medium	Basic (minimum)
Typically targeted PV system size	Utility-scale	Commercial-scale	Residential and small commercial
Maintenance Measures:			
Performance check (on-site or remote)	Daily	Weekly	Monthly
On-site visual inspections	6-months	1-year	1-year
Safety-related maintenance (general)	1-year	1-year	1-year
Performance related maintenance (general)	1-year	2-year	2-year
Inverter upkeep, site dependent (if not specified by manufacturer)	1-year	1-year	2-year
Insulation resistance checks *	1-year	1-year	2-year
Etc.			

Summarized from IEC working draft, Maintenance of PV Systems – IEC number not yet established

Periodic Inspections

	Visual Inspection	Thermographic Imaging	Performance Measurement	Safety Measurement
General site	✓			
PV Modules and Strings	✓	✓	✓	✓
Cables/connectors	✓	✓		
Inverters	✓	✓	✓	✓
Combiners/disconnects/isolators	✓	✓		
Mounting system	✓			
Trackers/Controllers	✓		✓	✓
Conduits/cable trays	✓			
Weather station / Sensors	✓			



Technical details for IECRE PV systems certification



Summarized from IEC working draft, Maintenance of PV Systems – IEC number not yet established

Corrective Maintenance and Troubleshooting

Corrective
Maintenance

Emergency shutdown

Non-emergency shutdown

Troubleshooting

Inverter trips or failures

Non-performance related failures

Diagnosing performance related issues

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Performance Methods



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Module and String-Level Measurements

IEC 61829–

Crystalline silicon PV array – on-site measurement of I-V characteristics

With emphasis on the Site Reporting Condition

Adequate performance measurements during commissioning allow for easier tracking and projection of component degradation over time.



Capacity Test

ASTM E 2939 –

Standard Practice for Determining Reporting Conditions and Expected Capacity for Photovoltaic Non-Concentrator Systems

ASTM E 2848 –

Standard Test Method for Reporting Photovoltaic Non-Concentrator System Performance

Long-Term Energy Test

IEC/TS 62947 Ed. 1.0

Photovoltaic system energy performance evaluation method

The performance of a PV system is dependent on the weather, seasonal effects, and other intermittent issues, so demonstrating that a PV system is performing as predicted requires determining that the system functions correctly under the full range of conditions relevant to the deployment site..... It is recommended that the test last 365 days.

Environmental factors include:

- Siting (structures, landscape)
- Irradiance (global, diffuse, direct normal)
- Ambient temperature
- Wind speed
- Soiling
- Weather events

Evaluating **Measured versus Expected** performance



Image from TUV

Standards development requires contribution from all parts of the solar community...one person cannot do it all.



Public image